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Sources of youth access to JUUL vaping products in the United States

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ABSTRACT

Introduction: This study assessed sources of youth access to JUUL vaping products, the highest selling brand of the most commonly used tobacco product among adolescents in the United States.

Methods: A cross-sectional online survey assessed use of JUUL vaping products in a non-probability, nationally representative sample of 9865 adolescents aged 13–17 years in the United States. Past 30-day JUUL users (n = 1537) were asked how they got the JUUL vaping products they had used in the past 30-days. Those who reported having bought JUUL products themselves were asked about the places and people from whom they had bought products. Population-weighted percentages and 95% confidence intervals are reported for each source of access.

Results: An estimated 79.6% (95% CI = 77.5–81.6%) of current JUUL users obtained JUUL products from at least one social source (e.g. ‘someone bought for me, someone offered to me’) in the past 30 days. By comparison, 20.0% [95% CI = 18.0–22.0%) of current users bought JUUL products themselves. Of 1322 youth who reported obtaining JUUL products from at least one source or by buying products themselves in the past 30 days, 77.5% (95% CI = 75.3–79.8%) had obtained JUUL products *exclusively* from social sources (i.e. they did not buy products directly), 17.2% (95% CI = 15.2–19.3%) obtained JUUL products *exclusively* by buying the products themselves (i.e. they did not obtain products from any social sources), and 5.2% (95% CI = 4.0–6.4%) had obtained JUUL products both from social sources *and* from buying the products themselves. Among youth who bought JUUL products themselves, the most common place of purchase was ‘a gas station or convenience store’ [53.1% (95% CI = 47.5– 58.6%)].

Conclusions: Youth who are currently using JUUL vaping products obtain these products predominantly through social sources, such as friends and peers. Youth sources of access to JUUL vaping products appear to mirror youth sources of access to other tobacco products. Reducing youth use of JUUL vaping products will require a greater focus on measures that deter or penalize legal-age purchasers who give or sell products to minors.

1. Introduction

In May 2016, the U.S. Food and Drug Administration (FDA), through its Center for Tobacco Products, finalized a rule – referred to as the ‘final deeming rule’ – that deemed all products meeting the statutory definition of “tobacco product” in section 70 201(rr) of the *Food Drug & Cosmetic (FD&C) Act* (21 U.S.C. 321(rr)) to be subject to chapter IX of the FD&C Act, as amended by the Family Smoking Prevention and Tobacco Control Act in 2010. In this final deeming rule, FDA clarified that all electronic nicotine delivery systems (ENDS: including, but not limited to, e-cigarettes, e-cigars, e-hookah, vape pens, personal vaporizers, electronic pipes, and ENDS components and parts (e.g. liquids, cartridges)) were now subject to the FDA’s chapter IX authorities, including the authority to restrict the sale of e-cigarettes to persons aged 18 years and older at retail outlets, and requiring photo ID for age

verification checks for person under the age of 27 years.

Despite the prohibition of retail sales to minors aged under age 18 in all states and territories, electronic cigarettes (‘e-cigarettes’) – battery-powered devices that can deliver nicotine and flavorings to the user in the form of an aerosol by heating a liquid rather than by burning tobacco – are the most commonly used tobacco product among middle and high school students in the United States, and have been so since 2014 (Wang et al., 2018). Youth use of e-cigarettes surged considerably between 2017 and 2018, with 4.9% of middle school students and 20.8% of high school students in 2018 estimated to have used an e-cigarette in the past 30 days (compared to 3.3% and 11.7%, respectively, in 2017). These data indicate that around 3.5 million middle and high school students have used an e-cigarette in the past 30 days, up from around 2 million in 2017. In response to these data, the FDA announced in September 2018 that e-cigarette use among youth had

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become “an epidemic”, and that much of the increase in youth use of e-cigarettes has been driven by one manufacturer – JUUL (Belluz, 2019; USDHHS, 2018).

The JUUL e-cigarette is a temperature-regulated nicotine vaping device that has been described as resembling a USB flash drive in size, weight and appearance. The JUUL e-cigarette is based on a two-part system: a pre-filled, disposable e-liquid pod that clicks into a small battery. All 0.7 mL e-liquid pods marketed by JUUL in the United States are designed to contain either 23-mg of nicotine (3% nicotine by weight) or 40-mg of nicotine (5% nicotine by weight). Contemporaneous with a rapid growth in sales of JUUL vaping products in 2018 were frequent media reports in which parents, educators, school superintendents, healthcare providers and public health experts claimed the use of JUUL e-cigarettes had become widespread among their students and children. Data from two national probability surveys conducted in 2018 estimate between 4% and 6% of 15–17 year olds have used a JUUL e-cigarette in the past 30 days (McKeganey & Russell, 2019; Vallone, Bennett, Xiao, Pitzer, & Hair, 2019).

As it is illegal to sell JUUL products to youth, understanding how youth are obtaining JUUL vaping products can inform more effective means of restricting youth access. Previous nationally representative studies have found that social sources (e.g. being offered, asking someone to buy) were the most common sources of 15–17 year olds’ access to cigarettes, e-cigarettes, cigarillos and hookah, with far fewer youth tobacco users having bought tobacco products themselves from a retail location (Tanski et al., 2018; Everett Jones & Caraballo, 2014). Specifically, 56.7% of 15–17-year-old past 30-day e-cigarette users reported obtaining e-cigarettes by asking someone else to give e-cigarette products to them or to buy e-cigarette products for them (Tanski et al., 2018). In contrast, 10.5% purchased e-cigarette products themselves from a retail location. The extent to which the sources of youth access to JUUL vaping products vary from how youth have been found to access to e-cigarettes more generally is not known, and is a core question of the current study.

To the extent that JUUL vaping products have become uniquely popular among U.S. youth, the possibility that the JUUL brand of vaping products may be having a larger effect on U.S. adolescent health compared to other brands and styles of e-cigarette provides a strong rationale for better understanding sources of youth access to JUUL vaping products specifically. This study examined self-reported sources of access to JUUL vaping products in the past 30 days in a nationally representative sample of adolescents aged 13–17 years in the United States.

2. Methods

2.1. Participants

Participants were adolescents aged 13–17 years in the United States who reported having heard of or seen a brand of e-cigarette called ‘JUUL’, and were children of adults who were enrolled as panelists of a Qualtrics’ internet research panel. Qualtrics’ internet research panels comprise a diverse sample of over 30 million adults in the United States who have volunteered to periodically receive invitations to complete surveys online in exchange for incentives. Panelists consent/give assent to each survey they decide to participate in and are free to withdraw from any survey at any time.

Participants were recruited to the study in two ways. First, panelists who were identified by Qualtrics as having at least one child aged 13–17 years living in the household were sent an invitation by email. Second, a notification of this survey opportunity was posted to online portals to which Qualtrics panelists have access. It was not possible to know how many panelists saw the study invitation posted in the online portals, or how many email invitations were received or read. To avoid self-selection bias, neither the survey invitation nor the portal notification included specific details about the survey contents or topics.

Recruitment quotas were set with the intention of constructing a non-probability sample that matched the U.S. adolescent population in terms of age, gender and U.S. census region. To correct for survey non-response and possible selection bias, a study-specific post-stratification weight was used to adjust the composition of the final sample to match the age, gender and regional distributions of U.S. adolescent population. Demographic and geographic distributions from the March 2017 supplement of the U.S. Census Bureau’s Current Population Survey (CPS) were employed as population benchmarks for sample recruitment and adjustment, and included gender (male, female), age (13, 14, 15, 16, 17), and census region (Northeast, Midwest, South, West).

Participants self-completed a survey online between 23 November and 13 December 2018. A total of 28,850 panelists clicked through to the informed consent form, of whom 3035 (10.5%) did not meet basic eligibility criteria (1839 did not have children; 1114 did not have a child aged 13–17 years living in the household; 82 did not live in the United States), 7093 (24.6%) did not give consent/assent to participate, and 6554 (22.7%) children screened out due to being unaware of e-cigarettes (n = 974) or unaware of a brand of e-cigarette called ‘JUUL’ (n = 5580). Of the 12,167 eligible children, 1136 (3.9% of invited) were screened out due to quota restrictions; 1159 (4.0% of invited) were excluded due to low quality or incomplete responses; and 8 (0.0% of invited) were excluded for failing to report their age. This left a final analytic sample of 9865 U.S. adolescents who were aware of e-cigarettes and aware of the JUUL brand of e-cigarettes.

2.2. Procedure

Clicking the web-link in the email invitation/portal notification routed the panellist to an online Parent Permission Form (PPF). This PPF explained that Qualtrics was seeking the panellist’s permission to invite their child to take part in an online survey about their child’s views and experiences of tobacco products, like cigarettes and e-cigarettes. The PPF provided information about the purpose of the study, who was conducting the study, what their child’s participation would involve, what their child would receive for participating, their child’s rights as a study participant – including their right to skip questions or withdraw at any time – how their child’s information would be protected, the contact details of the study director, assurances of participant anonymity and confidentiality, and contact details for the Qualtrics support centre and of the Institutional Review Board that was providing oversight of this study. Panelists were asked to allow their child to complete the survey and submit their answers in private.

When a panellist gave consent for their child to participate, the panellist was routed to an online Youth Assent Form (YAF), which they were asked to read and then ask their child to read carefully before deciding whether he/she wished to participate. The YPF provided the same information and assurances as the PPF. Participants were asked to complete the survey on their own in private and to submit their answers without showing them to anyone else. Participants were assured that neither their parents, their school nor anyone else would be shown the answers they gave to any question. The survey took around 25 min to complete. Upon completion, a message displayed thanking participants for their time and informing them that a credit equivalent to \$10 would be deposited to their parent’s panel account, and that their parent has been asked to give \$10 to the participant. This study was approved by Advarra Institutional Review Board (Approval no. 00030080, 2 October 2018).

2.3. Measures

2.3.1. Demographics

Questions assessed participants’ age, gender, ethnicity, race, school grade, and state of residence.

2.3.2. Use of JUUL products

Ever use of a JUUL e-cigarette was assessed by the question, “Have you ever used a JUUL e-cigarette, even once or twice?”. Participants who responded “No” to this question were defined as ‘never users of a JUUL e-cigarette’. Participants who responded “Yes” to this question were defined as ever users of a JUUL e-cigarette and subsequently asked, “When was the last time you used a JUUL e-cigarette, even one or two puffs? (Please choose the first answer that fits)”. Those who responded “Not during the past 30 days but sometime during the past 6 months”, “Not during the past 6 months but sometime during the past year”, “1 to 4 years ago” or “5 or more years ago” were defined as ‘former JUUL users’. Those who responded “Earlier today”, “Not today but sometime during the past 7 days” or “Not during the past 7 days but sometime during the past 30 days” were then asked: “During the past 30 days, on how many days did you use a JUUL e-cigarette? (1) 0 days; (2) 1 or 2 days; (3) 3–5 days; (4) 6–9 days; (5) 10–19 days; (6) 20–29 days; (7) All 30 days”. Participants who responded “1 or 2 days” or higher to this question were categorized as ‘past 30-day JUUL users’.

2.3.3. Sources of access to JUUL products in the past 30 days

Participants who reported having used a JUUL e-cigarette in the past 30 days were asked: “During the past 30 days, how did you get the JUUL e-cigarettes and JUUL refill pods you have used? (Select one or more) ((1) I bought them myself; (2) I had someone else buy them for me; (3) I asked someone to give me some; (4) Someone offered them to me; (5) I bought them from another person; (6) I took them from a store or another person; (7) I got them some other way)”.

Participants who responded “I bought them myself” were then asked: During the past 30 days, where did you buy the JUUL e-cigarettes and JUUL refill pods you have used? (Select one or more) ((1) A gas station or convenience store; (2) A grocery store; (3) A drugstore; (4) A mall or shopping center kiosk/stand; (5) On the Internet; (6) A vape store or other store that only sells e-cigarettes; (7) Some other place not listed here; (8) From a family member; (9) From a friend; (10) From someone at school; (11) From some other person that is not a family member or a friend; (12) None of the above”.

Participants who responded “Someone offered them to me” were then asked: “During the past 30 days, who has given you the JUUL e-cigarettes and JUUL refill pods you have used? (Select one or more) (1) A family member; (2) A friend; (3) Someone at school; (4) Some other person that is not a family member or a friend)”.

2.4. Data quality checks

Several manual and automated checks were implemented to ensure that participants who gave low quality or invalid responses were excluded from the analytic sample. Checks were conducted for straight-lining, geolocation, inattentiveness, speeding, duplicates and bots according to pre-specified criteria.

2.5. Data analysis

Population-weighted proportions and 95% confidence intervals are reported for each source from JUUL products were obtained in the past 30 days. Confidence intervals (CI) were derived using the normal approximation method. All reported *ns* are unweighted. Differences between the proportions of youth aged 13–14 years and youth aged 15–17 years who obtained JUUL products from each source were tested by *z* tests. *P* values ≤ 0.05 were considered statistically significant. All analyses were conducted using SPSS v.25 software.

3. Results

3.1. Sample characteristics

Demographic, cigarette smoking status and JUUL use status

Table 1

Demographic characteristics and cigarette smoking status of past 30-day JUUL users.

Variable	Unweighted n (Weighted %)
Total	1537 (100.0)
Demographic Variables	
Sex	
Male	842 (55.6)
Female	691 (44.1)
Missing	4 (0.3)
Age Group	
13–14	493 (32.9)
15–17	1,044 (67.1)
Race/Ethnicity	
Non-Hispanic, White [§]	1,110 (70.5)
Non-Hispanic, Black [§]	77 (5.0)
Non-Hispanic, Other [§]	96 (6.2)
Hispanic [†]	247 (17.9)
Missing	7 (0.4)
School Grade	
Middle School	298 (20.7)
High School	1224 (78.4)
Other grade/ungraded	15 (0.9)
U.S. Census Region	
Midwest	382 (20.3)
South	634 (36.6)
West	227 (23.6)
Northeast	292 (19.3)
Missing	2 (0.1)
Cigarette Smoking Status	
Current Smoker	648 (42.8)
Former Smoker	590 (38.4)
Never Smoker	203 (12.6)
Missing	96 (6.2)

[§] Blacks, whites, and others are non-Hispanic.

[†] Includes Mexican, Cuban, Puerto Rican and ‘other Hispanic’ ethnicity. Hispanic persons could be of any race.

characteristics of the analytic sample are summarized in Table 1. Participants were predominantly male (51.0%), aged 15–17 years (60.5%), non-Hispanic White (68.6%), and living in the South (37.2%). Approximately 13.2% were past 30-day cigarette smokers, 24.7% were former smokers and 62.0% were never smokers. With regard to use of a JUUL e-cigarette, 15.6% were past 30-day users, 11.5% were former users and 72.7% were never users. The remainder of the analyses were restricted to participants who reported having used a JUUL e-cigarette in the past 30 days *and* reported the number of days in the past 30 days on which they had used a JUUL (unweighted *n* = 1537; weighted percentage of total sample = 15.7%).

3.2. Sources of access to JUUL vaping products

Fig. 1 presents the sources from which 1537 youth obtained JUUL vaping products in the past 30 days. Social sources were the most common sources of access to JUUL products. An estimated 79.6% (95% CI = 77.5–81.6%) of youth obtained JUUL products from at least one social source in the past 30 days. By comparison, 20.0% [95% CI = 18.0–22.0%] of youth directly bought JUUL products themselves. Youth aged 13–14 years and youth aged 15–17 years were comparably likely to have obtained JUUL products from a social source [80.1% (95% CI = 76.6–83.6%) vs. 79.4% (95% CI = 76.9–81.8%)] and comparably likely to have bought JUUL products directly.

Of 1322 youth who reported obtaining JUUL products from at least one source or by buying products themselves in the past 30 days, 77.5% (95% CI = 75.3–79.8%) had obtained JUUL products *exclusively* from social sources (i.e. they did not buy products directly), 17.2% (95% CI = 15.2–19.3%) obtained JUUL products *exclusively* by buying the products themselves (i.e. they did not obtain products from any social sources), and 5.2% (95% CI = 4.0–6.4%) had obtained JUUL products

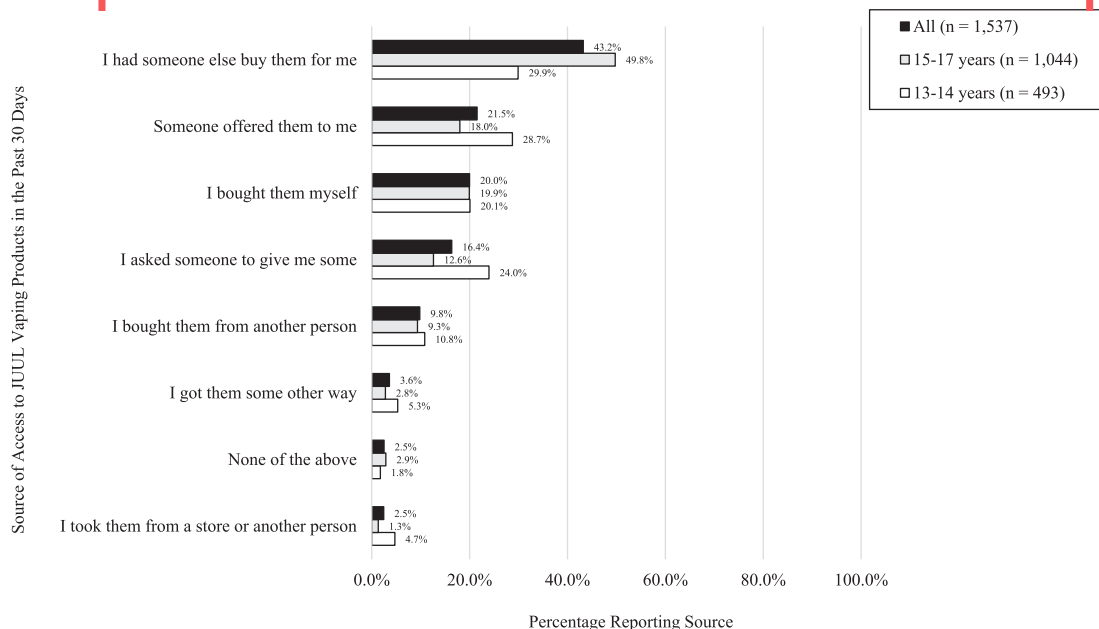


Fig. 1. Sources of youth access to JUUL vaping products in the past 30 days. Note: Percentages are population-weighted; ns are unweighted.

both from social sources and from buying the products themselves.

The most common social sources of JUUL products were ‘I had someone else buy them for me’ [43.2% (95% CI = 40.8–45.7%)], ‘someone offered them to me’ [21.5% (95% CI = 19.5–23.6%)], and ‘I asked someone to give me some’ [16.4% (95% CI = 14.5–18.2%)]. Youth aged 15–17 years were significantly more likely than youth aged 13–14 years to have obtained JUUL products by having someone else buy JUUL products for them ($p < 0.05$). In contrast, youth aged 13–14 years were significantly more likely than youth aged 15–17 years to have obtained JUUL products through someone offering JUUL products to them, and through asking someone to give them JUUL products ($ps < 0.05$). An estimated 9.8% (95% CI = 8.3–11.3%) bought JUUL products from another person.

3.3. Places of purchasing JUUL vaping products

Among 297 youth who bought JUUL products themselves in the past 30 days, the most common place of purchase was ‘a gas station or convenience store’ [53.1% (95% CI = 47.5–58.6%)] (Fig. 2); this equated to 10.6% (95% CI = 47.5–58.6%) of all youth past 30-day JUUL users having accessed JUUL products in the past 30 days by buying the products themselves from a gas station or convenience store. Youth aged 13–14 years were significantly more likely than youth aged 15–17 years to have bought JUUL products from ‘a grocery store’ [43.1% (95% CI = 33.5–52.7%) vs. 20.8% (95% CI = 15.2–26.3%) ($p < 0.05$)]. Conversely, youth aged 15–17 years were significantly more likely than youth aged 13–14 years to have bought JUUL products from ‘a vape store or other store that only sells e-cigarettes’ [29.6% (95% CI = 23.4–35.8%) vs. 5.9% (95% CI = 1.3–10.4%) ($p < 0.05$)]. Youth aged 13–14 years were also significantly more likely than youth aged 15–17 years to have bought JUUL products from ‘a drug store’ or ‘a mall or shopping center kiosk/stand’. Buying JUUL products on the internet was reported by 15.3% (95% CI = 11.2–19.3%) of youth who had bought JUUL products themselves, which equated to 3.0% (95% CI = 2.2–3.9%) of all youth past 30-day JUUL users. Buying JUUL products from retail locations was more common than buying from other people.

3.4. Persons offering JUUL vaping products

Among 330 youth who had been offered JUUL products by someone else in the past 30 days, youth were most likely to have been offered JUUL products by ‘a friend’ [61.6% (95% CI = 56.3–66.8%)] or by ‘someone at school’ [40.8% (95% CI = 35.6–46.1%)] (Fig. 3).

4. Discussion

This study examined the sources from which American youth are accessing JUUL vaping products, the highest selling brand of the most commonly used tobacco product among youth in the United States. Within this nationally representative sample of adolescents aged 13–17 years, social sources such as friends and peers were the predominant source of access to JUUL vaping products. The majority of current JUUL users reported they had obtained JUUL products entirely from social sources (i.e. no purchasing from a retail location) in the past 30 days. Having someone else buy JUUL vaping products for them was the most common social source of access. Buying JUUL products directly from a retail location was far less common, and buying JUUL products entirely from retail purchases was uncommon. Of the minority of youth who purchased JUUL products themselves, gas stations and convenience stores were the most common places of purchase.

Youth appear to be accessing JUUL vaping products from the same social sources that have been found to be the predominant source of youth access to other tobacco products, including cigarettes, e-cigarettes, cigarillos and hookah tobacco (Tanski et al., 2018). That the majority of youth access JUUL vaping products and other tobacco products through friends and peers, without often, if ever, setting foot in a retail store or visiting an e-commerce website, reduces the likelihood that youth use of JUUL products will be reduced in communities in which the legal age for purchasing tobacco products is 18 years. Public health laws have typically sought to restrict youth access to tobacco products by implementing and enforcing laws and ordinances that prevent the retail sale of tobacco products to minors younger than age 18, and concerted enforcement of access restrictions via minimum purchase age and photo ID checks have contributed to reductions in the prevalence of youth use of cigarettes (DiFranza, 2012; Winickoff, Gottlieb, & Mello, 2014). However, the positive impact of a minimum tobacco purchase age of 18 is undermined by the fact that 18, 19 and

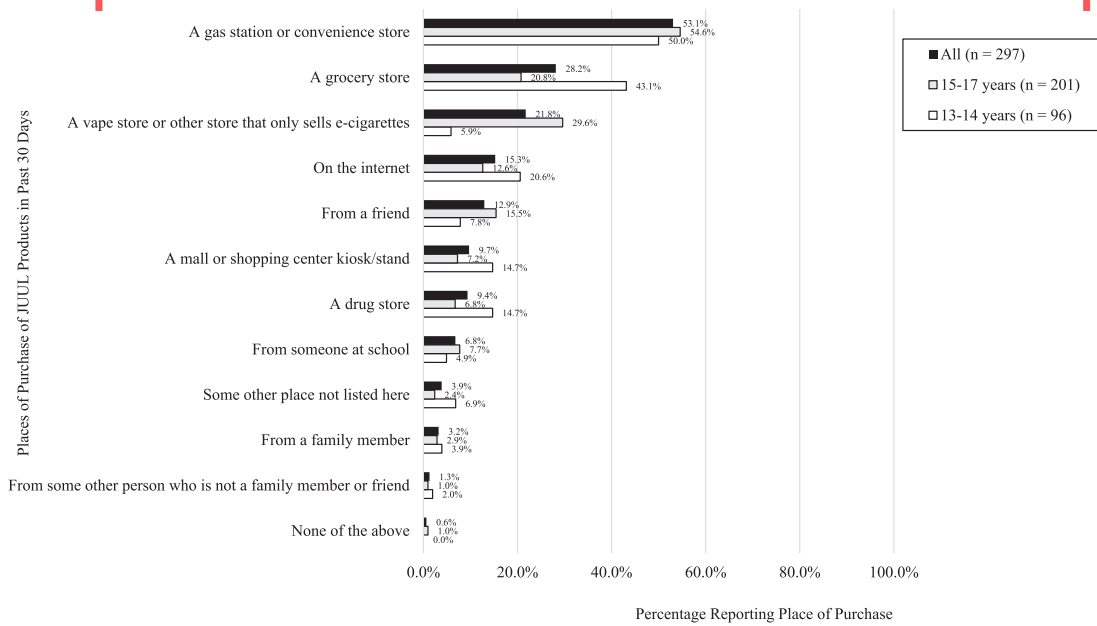


Fig. 2. Places from which youth bought JUUL vaping products themselves in the past 30 days. Note: Percentages are population-weighted; ns are unweighted.

20 year olds can, in most communities in the United States, legally purchase tobacco products and then (illegally) give or sell these products to younger friends or family members (DiFranza & Coleman, 2001). Other research has shown that adults aged 18 and 19 years are significantly more likely than adults aged 20–24 years (59.0% vs. 39.3%) to have been asked by smokers under 18 years of age to buy cigarettes for them (Ribisl, Norman, Howard-Pitney, & Howard, 1999).

That the majority of youth users of JUUL vaping products in this study had accessed JUUL products through social sources suggests that youth access to JUUL products may be more effectively reduced by laws and ordinances that have the effect of disrupting the social availability of JUUL products to youth. Given that adolescents aged 15–17 years are significantly less likely to have friends aged 21 years older than they are to have friends aged 18–20 years (Ahmad, 2005), raising the minimum purchase age for e-cigarettes from 18 to 21 would reduce the number of peers in their social circles who are of legal age to purchase JUUL

products, and so potentially reduce their opportunities to obtain JUUL products. There is good evidence that implementing an ordinance to raise the minimum tobacco purchase age from 18 to 21 is associated with greater reductions in past 30-day smoking rates among youth – an effect that is consistent across genders, ethnicities and high school grade levels – and greater reductions in cigarette purchases among current smokers compared to surrounding communities where such an ordinance was not implemented (Kessel Schneider, Buka, Dash, Winkoff, & O'Donnell, 2016). However, given evidence that e-cigarette aerosol typically contains fewer and lower concentrations of toxicants and carcinogens than are typically carried in smoke from combustible tobacco cigarettes (National Academies of Sciences, Engineering and Medicine, 2018), local and state proposals to prohibit the sale of JUUL products in a jurisdiction to 18, 19 and 20 year olds who are most likely to be the friends or peers that youth will ask to buy JUUL and other vaping products for them need also to consider the

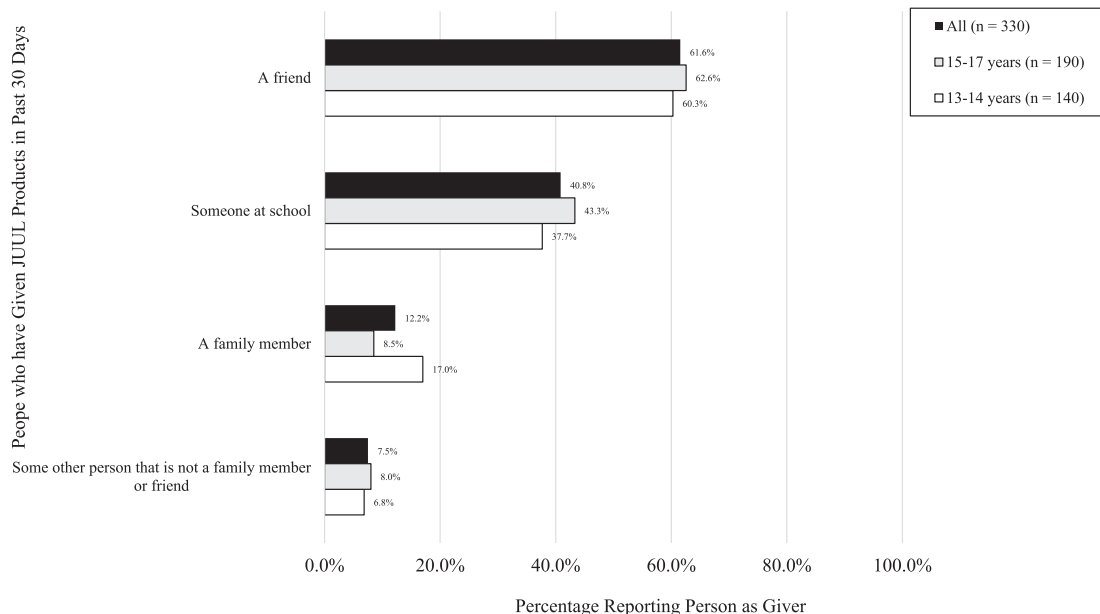


Fig. 3. People who have given JUUL vaping products to youth in the past 30 days. Note: Percentages are population-weighted; ns are unweighted.

potential consequences of such a prohibition on the tobacco use behaviors of young adults who are using vaping products as an alternative to continuing to smoke conventional cigarettes. Additionally, raising the minimum purchase age for e-cigarettes from 18 to 21 would only have potential to reduce youth use of e-cigarettes in communities in which compliance checks and penalization of retail and Internet violations of local and state prohibitions of the sale of vaping products to minors are maintained, and in which legal-age purchasers who buy JUUL products in order to give or sell them to youth are penalized.

The results of this study must be interpreted in the context of several limitations. First, it is important to stress that, due to the non-probabilistic nature of study recruitment and setting prior awareness of the JUUL brand of e-cigarette as an eligibility criterion for participation in this study, the proportion of youth who reported past 30-day JUUL use in this study (weighted percentage = 15.7%) should not be interpreted as an estimate of the prevalence of JUUL use in the adolescent population. Second, though the study sample was constructed to be representative of U.S. adolescents in terms of age, gender and census region, the generalizability of results to U.S. adolescents may be limited as the study sample was recruited from online research panels, and because approximately 42.2% of invited, consenting and otherwise eligible adolescents were excluded because they had not seen or heard of a brand of e-cigarette called 'JUUL' before taking part in this study. A number of studies have shown, however that the application of corrections (e.g. quota-based recruitment and population weighting) to non-probability samples is effective in producing prevalence estimates that match those estimated from probability samples (MacInnis, Krosnick, Ho, & Cho, 2018; Yeager, Krosnick, & Chang, 2011). Additionally, the corrections applied in this study were specific to the U.S. adolescent population, and so results are unlikely to represent youth perceptions of the JUUL e-cigarette in other countries.

Third, the survey did not ask youth whether they had attempted to purchase JUUL products in a retail location in the past 30 days, nor the number of attempts to purchase JUUL products in a retail location that resulted in a sale/refusal of sale. Consequently, we cannot know what proportion of attempted retail purchases resulted in a sale/refusal of sale, nor what proportion of youth had been refused sale on at least one occasion. Therefore, while the available data indicate that 20.0% of past 30-day JUUL users bought products themselves in a retail location (i.e. sale was not refused), we cannot know the percentage of all attempted retail purchases that resulted in a sale.

5. Conclusions

Youth access to JUUL vaping products occurred predominantly through social sources. The majority of youth JUUL users obtained JUUL products entirely through social sources, without ever purchasing JUUL products themselves. Of the minority of youth who reported purchasing JUUL products themselves, gas stations and convenience stores were the most common retail source. Local and state laws that disrupt the social availability of JUUL vaping products to youth and young adults may be the most effective in reducing youth access to the JUUL products. However, policy-makers must weigh the potential reductions in youth e-cigarette use against the potential that raising the minimum purchase age for vaping products from 18 to 21 will have the adverse effect of reducing young adults' access to and use of vaping products that may be substantially less harmful to health compared to continuing to smoke conventional cigarettes.

Ethics Approval and consent to participate

This study was approved by Advarra Institutional Review Board (Approval no. 00030080, 2 October 2018). Informed consent to participate was obtained from all participants. The Parent Permission Form and Youth Assent Form used in this study are available from the corresponding author on reasonable request.

Role of funding sources

Funding for this study was provided by JUUL Labs Inc. JUUL Labs Inc. had no input or control over the study design, contents of the survey instrument, sample recruitment, data analysis, interpretation, or reporting of findings. The authors alone are responsible for the contents, production and decision to report this study. The raw data collected in this study have not been shared with the funder, but will be shared with the U.S. Food and Drug Administration (FDA).

Author contributions

NM and CR co-wrote the study protocol, developed the survey instrument, and were responsible for the majority of the writing involved in the manuscript. CR, EK and FH conducted the data analysis. EK and FH assisted with literature searches, and assisted in the editing of the manuscript. All authors read and approved the manuscript.

Declaration of competing Interest

In the past 12 months, the Centre for Substance Use Research (CSUR) has received funding from JUUL Labs Inc. to design and conduct research on the impact of JUUL vapor products on tobacco use behaviors, perceptions and intentions among adults and adolescents in the United States.

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